



## PyPS a programmable pass manager

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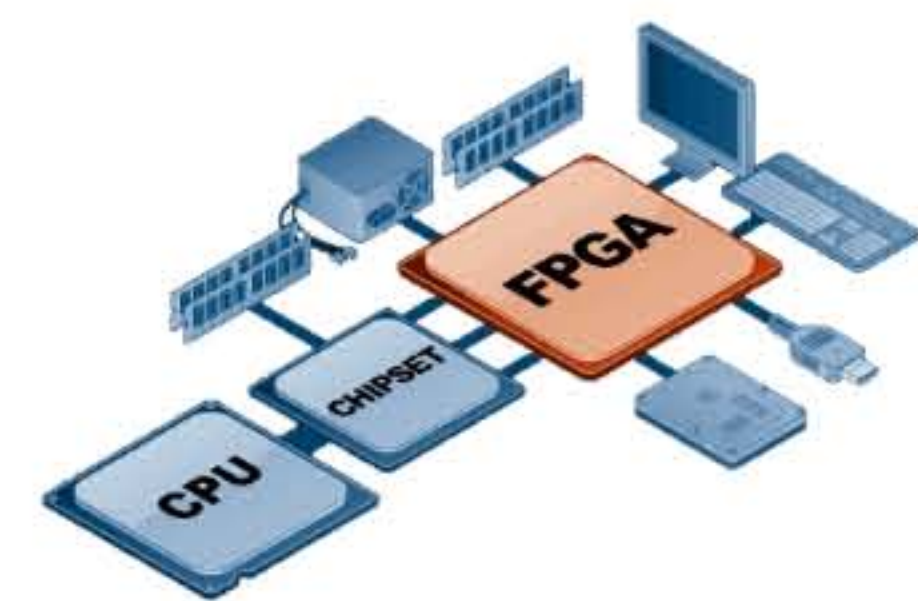
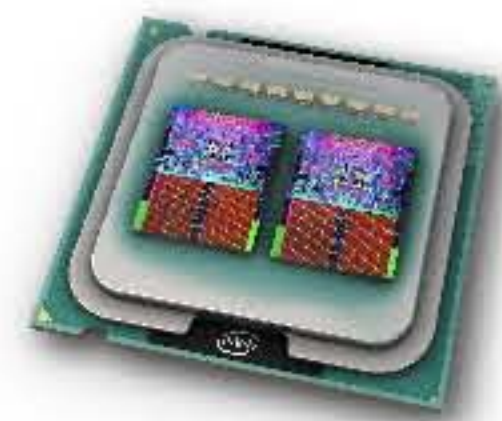




## 1 - Complex Environment



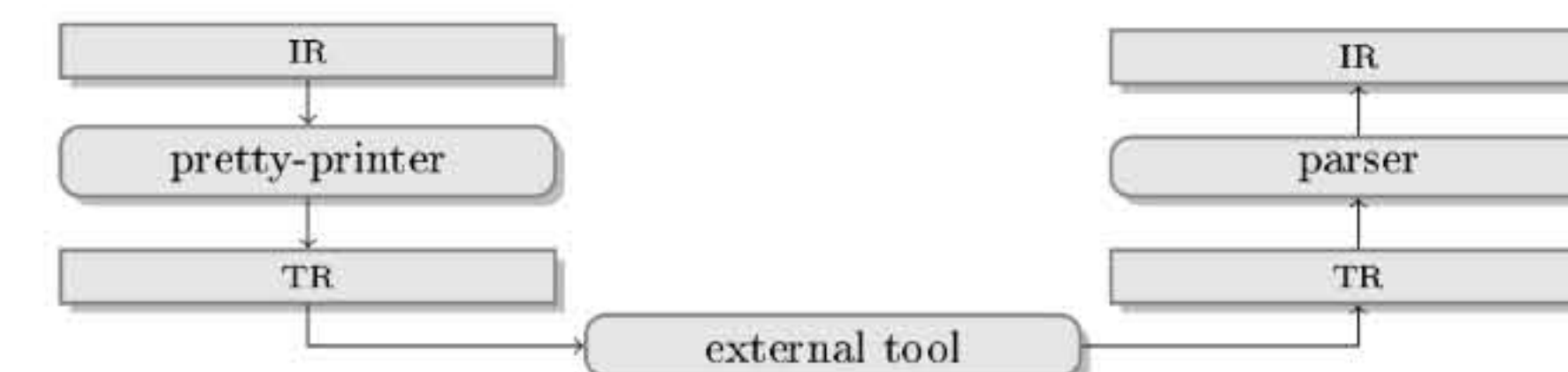
Parallel and heterogenous hardware  
Compilers must be multi-target.  
collaborate, and be specialized.



## 2 - Source-to-Source

Many source-to-source successful compilers.  
Flexible transformation systems for  
heterogeneous computing :

- parallelism detection algorithm,
- variable privatization,
- communication generation,
- etc.



## 3 - Model for Code Transformations

Sequencing of code transformations is the  
compiler core.

Formal point of view for interactions between  
passes : several transformation composition rules.

A code transformation is an application  $P \rightarrow P$  that preserves  
the semantics of the program, that is to say:

$$\forall p \in \mathcal{P}, \forall v_{in} \in \mathcal{V}_{in}(p), \quad P(p, v_{in}) = P(t(p), v_{in})$$

A failsafe operator :

$$\forall t \in \mathcal{T}, \forall p \in \mathcal{P}, \quad \tilde{t}(p) = \begin{cases} t(p) & \text{if } t(p) \neq \text{error} \\ p & \text{otherwise} \end{cases}$$

A failsafe composition:

$$\forall t_0, t_1 \in \mathcal{T} \times \mathcal{T}, \quad t_1 \circ t_0 = \tilde{t}_1 \circ \tilde{t}_0$$

A conditional composition:

$$\forall t_0, t_1, t_2 \in \mathcal{T} \times \mathcal{T} \times \mathcal{T}, \forall p \in \mathcal{P} \quad ((t_1, t_2) \circ t_0)(p) = \begin{cases} (t_1 \circ t_0)(p) & \text{if } t_0(p) \neq \text{error} \\ t_2(p) & \text{otherwise} \end{cases}$$

An error propagation operator :

$$\forall t_0, t_1 \in \mathcal{T} \times \mathcal{T}, \quad t_1 \circ t_0 = (t_1, \text{id}_{\mathcal{T}}) \circ t_0$$

# PyPS

# a programmable pass manager

## 4 - Based on a Scripting Language

on the shoulders of giants python  
powered  
print "Hello, world!"

No DSL, does not reinvent the wheel, build over  
a high level language with a rich ecosystem wich  
widens the set of possibilities.

## 7 - Targets

**OpenMP** ; classic scheme but still illustrating basic functionalities.

**TERAPIX** is a fpga based accelerator for image processing from thales.

**SAC** vectorizer targets AVX, SSE, or NEON.

**An Iterative Compiler** ; try different compilation schemes or  
transformation flavors.

**Par4All** makes use of other compilers to provide automatic  
parallelization of applications to multiple hybrid architectures.

## 6 - Control Structures

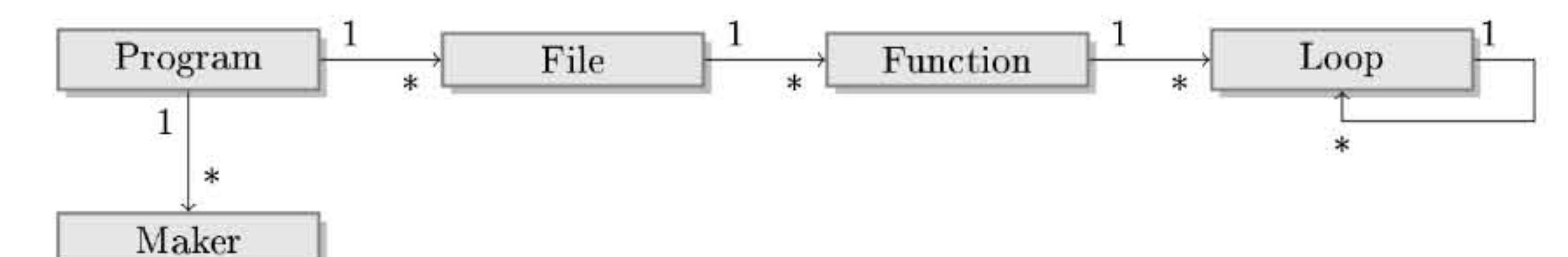
**Conditionals**: manage switches, choose different  
compilation schemes.

**For loops**: iterate over the callgraph, loop nests.

**Exceptions**: recover from compilation failure, impossible  
transformations, etc.

**While loops**: look for fixed point for sequence of passes.

## 5 - Abstractions



**Classes**: high level program representation

high level compilation scheme

**Methods**: compose transformations into more complex ones

**Inheritance**: compose scheme for heterogeneous targets

## Related Work

Automated Programmable Control and Parameterization of Compiler Optimizations. Yi. CGO 2011.

Finding effective optimization phase sequences. Kulkarni et al. LCTES 2003.

MILEPOST GCC: machine learning based research compiler. Fursin et al. GCC Developers' Summit, 2008.



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